

# **Point Source Inventory Development**



## **Calculating PM<sub>2.5</sub> Emissions: Data & Tools**

### **Section 3; Part I**

Randy Strait  
E.H. Pechan & Associates, Inc.

# Calculating PM<sub>2.5</sub> Emissions for Point Sources






## OVERVIEW

- Point source emissions reporting requirements
- Sources of filterable versus condensable emissions
- How are PM<sub>2.5</sub> emissions measured?
- Particle size distributions and emission factors
- NEI Methods for calculating filterable & condensable PM emissions
- Future information needs

# Point Source Emissions Reporting Requirements

## Existing Reporting Requirements (40 CFR 51.322)

- Must report actual annual emissions/data elements annually
- Thresholds apply statewide
- Facility-level thresholds
  - All criteria pollutants  100 TPY  
(except CO & Lead)
  - CO  1,000 TPY
  - Lead  5 TPY

# Point Source Emissions Reporting Requirements

## Consolidated Emissions Reporting Rule (CERR)

- Consolidates EI reporting for criteria pollutants
- Must report actual annual emissions/data elements
- Thresholds apply statewide
- Divides point source reporting frequencies into two classes
  - Type A Sources
    - | Must report annually
    - | Thresholds higher than current annual reporting thresholds
  - Type B Sources
    - | Must report once during each 3-year cycle
    - | Thresholds same as existing reporting thresholds
      - Reduces number of facilities currently subject to annual reporting

# Sources of Filterable versus Condensable Emissions



- Combustion sources typically emit both filterable and condensable PM emissions
  - Boilers
  - Furnaces/kilns
  - Internal combustion engines (reciprocating & turbines)
- Fugitive dust sources emit filterable emissions only
  - Storage piles
  - Unpaved roads at industrial sites

# How Are PM<sub>2.5</sub> Emissions Measured?

<b><u>EPA Method</u></b>	<b><u>Federal Register Reference (Date)</u></b>	<b><u>Description of Method</u></b>
5	36 FR 24877 (12/ 23/ 71)	PM from stationary sources
5A	47 FR 34137 (08/ 06/ 82)	PM from asphalt processing and asphalt roofing
5B	51 FR 42839 (11/ 26/ 86)	Nonsulfuric acid PM
5C	tentative	PM from small ducts
5D	49 FR 43847 (10/ 31/ 84)	PM from (positive pressure) fabric filters
5E	50 FR 07701 (02/ 25/ 85)	PM from wool fiberglass plants
5F	51 FR 42839 (11/ 26/ 86)	Nonsulfate PM
5G	53 FR 05860 (02/ 26/ 88)	PM from wood heaters -dilution tunnel
5H	53 FR 05860 (02/ 26/ 88)	PM from wood heaters -stack
17	43 FR 07568 (02/ 23/ 78)	In-stack filtration method for PM
201	55 FR 14246 (04/ 17/ 90)	PM/ PM10 - exhaust gas recycle (ERG) procedure
201A	55 FR 14246 (04/ 17/ 90)	PM/PM10 -constant sampling rate procedure
202	56 FR 65433 (12/ 17/ 91)	Condensable PM emissions/stationary sources
29	59 FR 48259 (09/ 20/ 94)	Metal emissions (and PM)
PRE4		DRAFT Method for PM10/PM2.5

# How Are PM<sub>2.5</sub> Emissions Measured?



- Information Sources on Test Methods
  - Methods are available from EPA's Emission Measurement Center at <http://www.epa.gov/ttn/emc/>
  - The following publication (Chapter 3) provides nice summary of different PM measurement methods for stack and fugitive dust sources:
    - “Stationary Source Control Techniques Document for Fine Particulate Matter,” October 1998 (EPA-452/R-97-001)
  - State/local Agency Source Testing Experts/Rules

# How Are PM<sub>2.5</sub> Emissions Measured?



## ■ EPA Reference Method 5

- In-stack procedure for measuring filterable PM emissions collected on filter
- Does not measure condensable PM
- Filter heated outside stack
- Cascade impactors placed in sampling train to obtain particle size distributions for filterable PM
- Basis for most AP-42 particle size data

## ■ EPA Reference Method 17

- Same as Method 5 except filter heated inside stack
- Method not used often



# How Are PM<sub>2.5</sub> Emissions Measured?



- EPA Reference Method 201/201a
  - In-stack measurement procedure for PM emissions equal to or less than an aerodynamic diameter of nominally 10 µm from stationary sources
  - Method 201: Exhaust Gas Recycle Procedure (infrequently used)
  - Method 201a: Constant Sampling Rate Procedure
  - Measures filterable PM collected on filter
  - Does not measure condensable PM
- EPA Reference Method 202
  - Stack measurement procedure for condensable PM
  - Can be ran with Method 201/201a

# How Are PM<sub>2.5</sub> Emissions Measured?

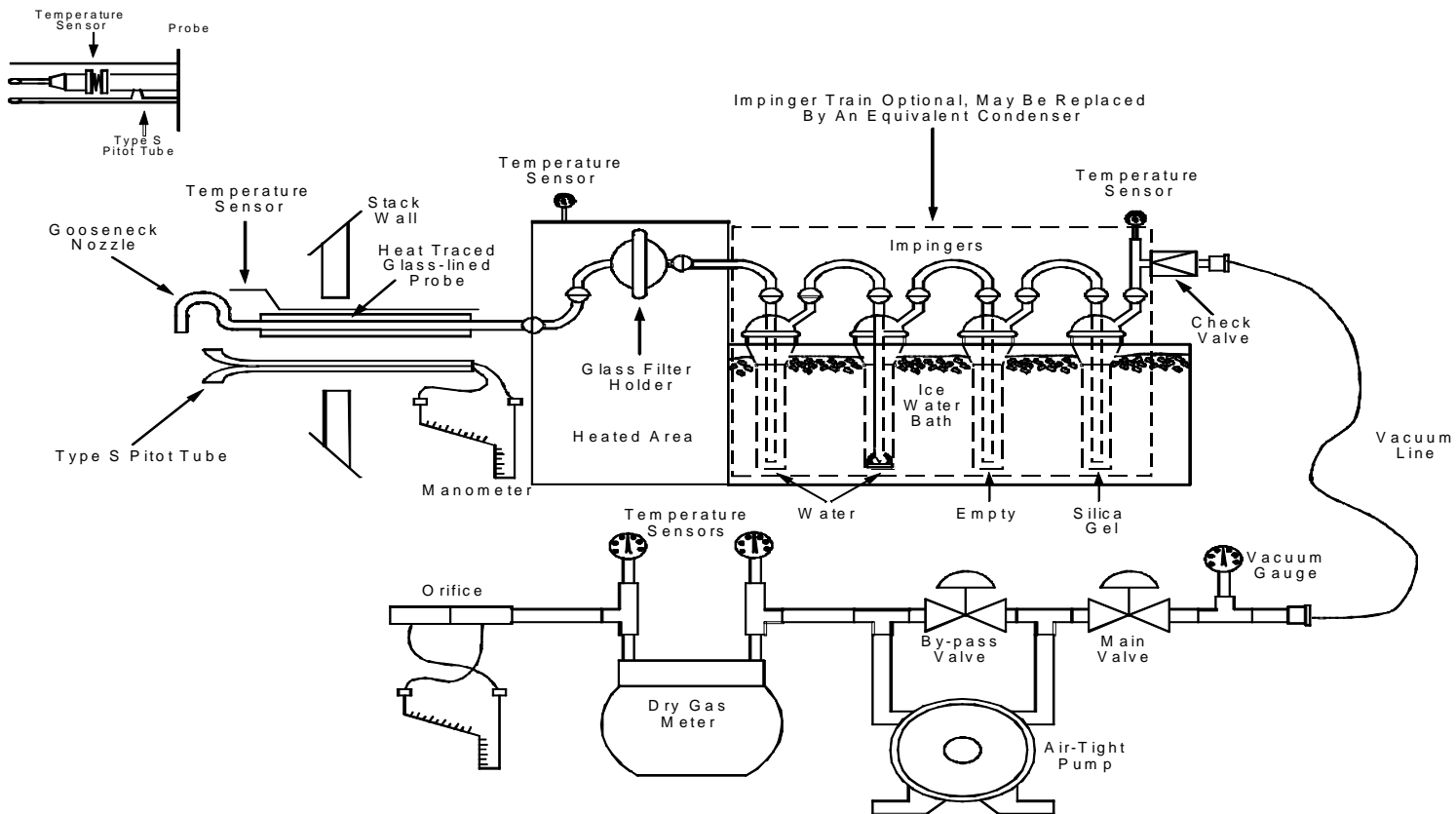


## ■ EPA Preliminary Method 4

- Being developed to measure filterable PM<sub>10</sub> and PM<sub>2.5</sub>
- A combination of Method 201A for PM<sub>10</sub> and the PM<sub>2.5</sub> cyclone from a five stage cascade cyclone train
- Measures filterable PM collected on filter
- Does not measure condensable PM

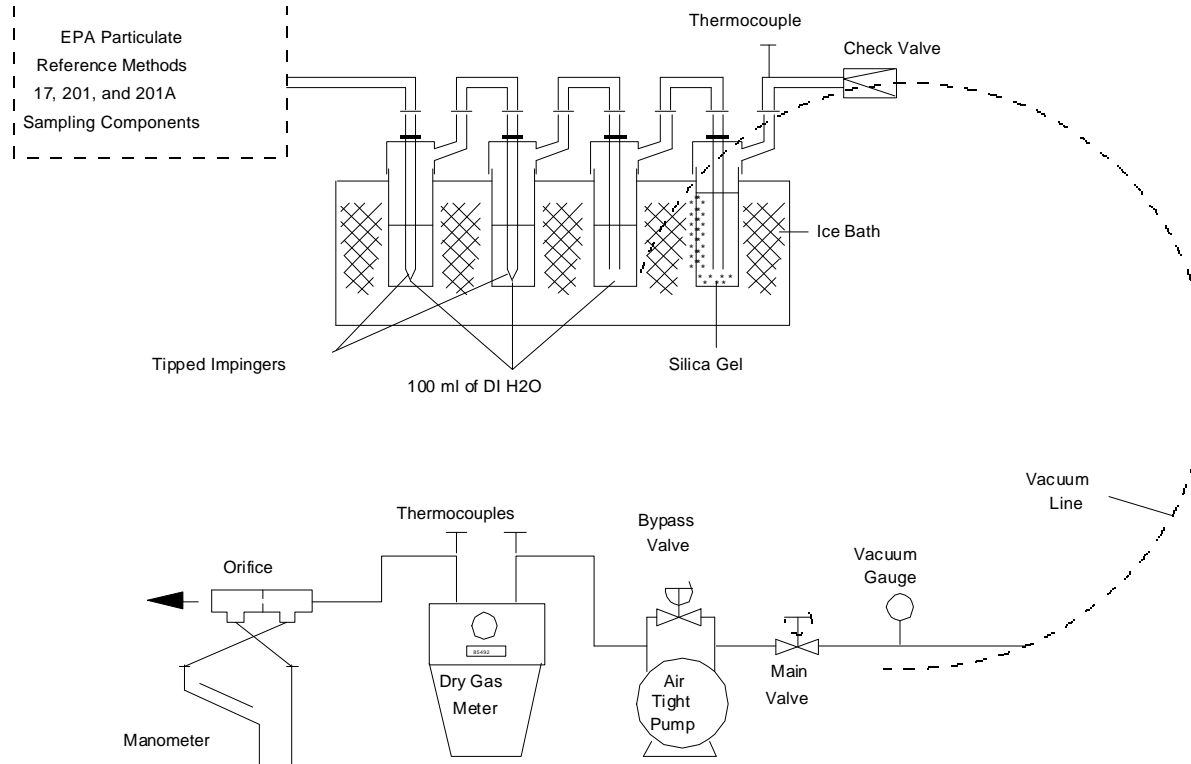
# How Are PM Emissions Measured?

## Method 5 Sampling Train




# How Are PM Emissions Measured?

## Method 202 Condensable PM Sampling Train



# When Are PM<sub>2.5</sub>/PM<sub>10</sub> Emissions Measured?



- PM<sub>2.5</sub>/PM<sub>10</sub> emissions measured when required by:
  - Specific rule (e.g., NSR/PSD)
  - PM<sub>2.5</sub>/PM<sub>10</sub> limits included in SIP
  - SIP control strategy or attainment demonstration depends on control / modeling of sources of PM<sub>2.5</sub>/PM<sub>10</sub>
  - Requested by regulatory authority

# AP-42 Particle Size Data



- **Provides particle size distribution data and particle-size-specific emission factors**
  - Used AP-42 if source-specific data are not available
    - | Use data in chapters for specific source categories first
    - | Use Appendix B-1 data next
    - | Use Appendix B-2 data last
  - AP-42 chapters not always clear on what source test methods were used to develop particle size data
    - | See background documents for AP-42 chapters for details
  - AP-42 available on EPA/OQAPS CHIEF web site
    - | (<http://www.epa.gov/ttn/chief/>)

# AP-42 Particle Size Data (Cont.)



## ■ **Appendix B-1 (Particle Size Distribution Data and Sized Emission Factors for Selected Sources)**

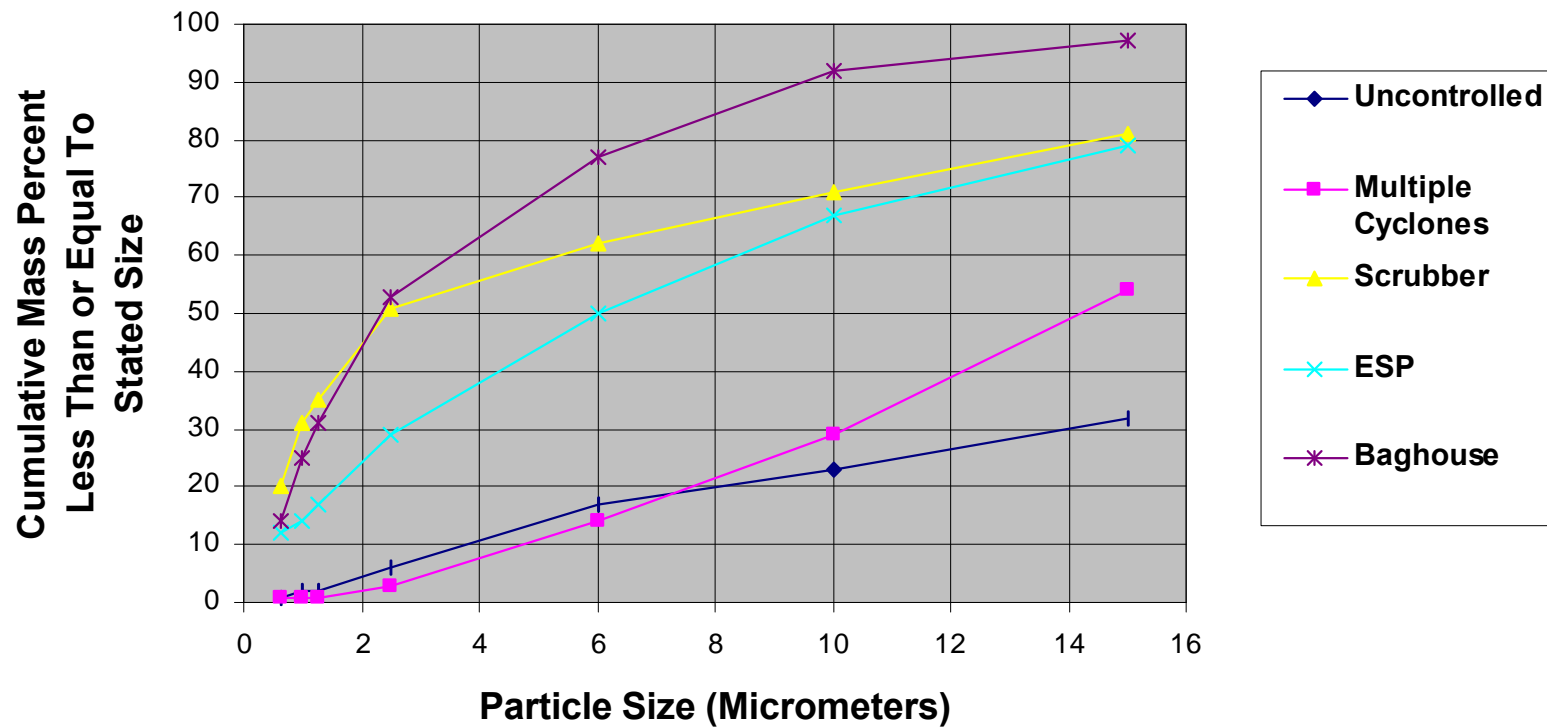
- Based on documented emission data available for specific processes

## ■ **Appendix B-2 (Generalized Particle Size Distributions)**

- Based on data for similar processes generating emissions from similar materials
- Generic distributions are approximations
- Use only in absence of source-specific distributions

# AP-42 Particle Size Data

**Cumulative Particle Size Distribution for Dry Bottom Boilers  
Burning Pulverized Bituminous/Subbituminous Coal  
(AP-42, Table 1.1-6)**





# AP-42 Particle Size Data (Cont.)

## Size-Specific Emission Factors for Dry Bottom Boilers Burning Pulverized Bituminous and Subbituminous Coal (AP-42, Table 1.1-6)

(Cumulative Emission Factor (lbs of pollutant/ton of coal burned))

Particle Size (microns)	Uncontrolled	Multiple Cyclones	Scrubber	ESP	Baghouse
15	3.2A	1.08A	0.48A	0.064A	0.02A
10	2.3A	0.58A	0.42A	0.054A	0.02A
6	1.7A	0.28A	0.38A	0.024A	0.02A
2.5	0.6A	0.06A	0.3A	0.024A	0.01A
1.25	0.2A	0.02A	0.22A	0.01A	0.006A
1.00	0.2A	0.02A	0.18A	0.01A	0.006A
0.625	0.1A	0.02A	0.12A	0.01A	0.002A

A=coal ash weight percent, as fired. For example, if coal ash weight is 8.2%, then A=8.2.

Particle-size-specific EFs = (total mass EF) x (cumulative weight % of particles less than specified diameter)

# NEI Methods for Calculating PM<sub>2.5</sub> Emissions



## Starting Point for 1999 NEI Version 2.0

### ■ Filterable Emissions

- Use State/Local/Tribal (S/L/T) PM<sub>25</sub>-FIL emissions, if available
- Else, use PM Calculator to estimate PM<sub>25</sub>-FIL emissions if S/L/T agency provides filterable or primary PM (PM<sub>10</sub>) emissions
  - If no PM emissions provided, use emissions in 1999 NEI Ver. 1.5
    - Emissions grown from 1996
    - 1996 emissions estimated with PM Calculator if not provided by S/L/T agency
- Note: prior versions of NEI did not specify form of PM; assumed to be filterable

# NEI Methods for Calculating PM<sub>2.5</sub> Emissions

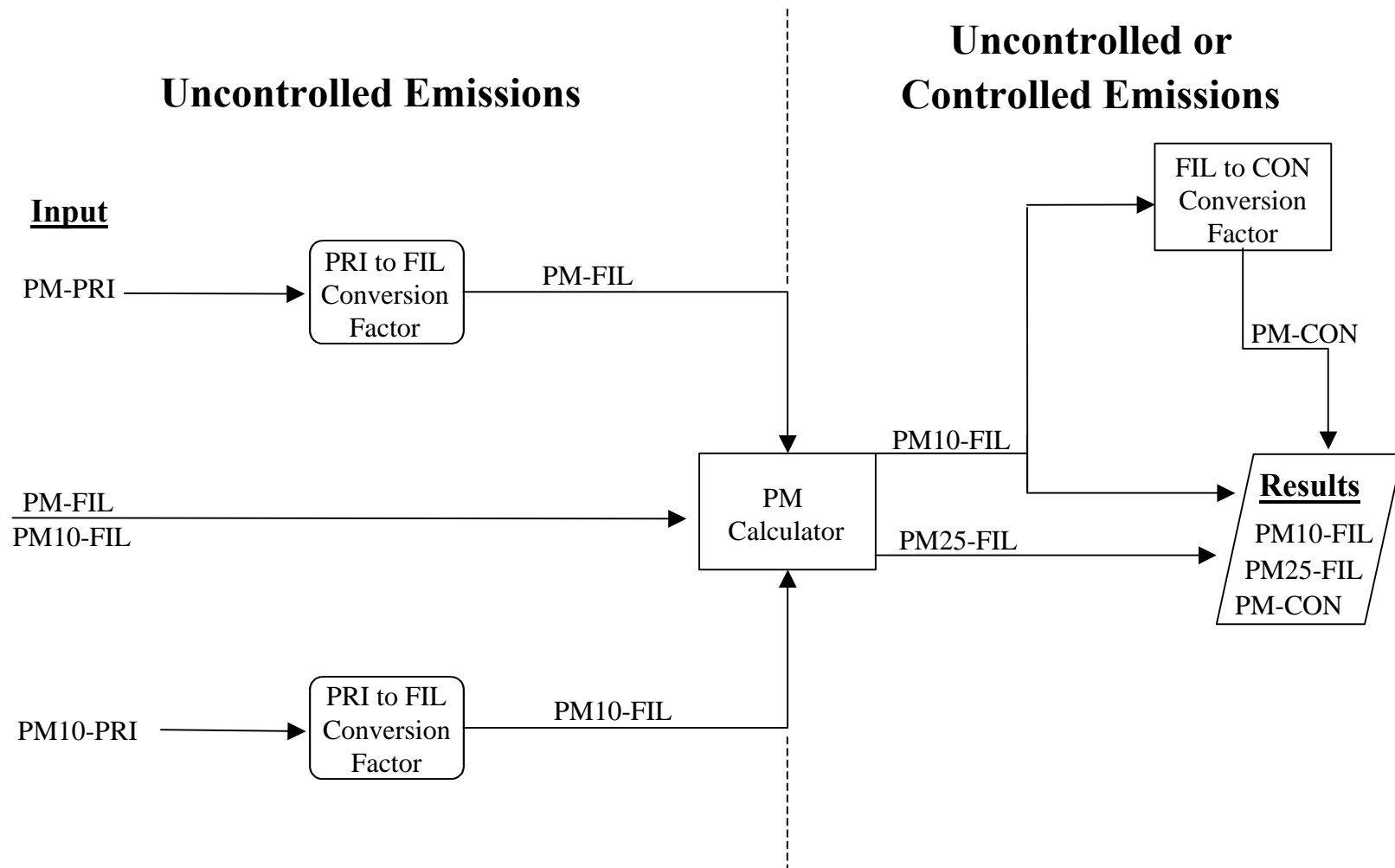


## Starting Point for 1999 NEI Version 2.0

### ■ Condensable Emissions

- Use S/L/T PM-CON emissions, if available
- Else, apply factors to PM<sub>10</sub>-FIL to estimate PM-CON emissions
- PM-CON is almost always PM<sub>2.5</sub>
- Condensable mass fraction is same for primary PM, PM<sub>10</sub>, and PM<sub>2.5</sub>
- 1999 NEI will include PM-CON emissions for the first time

# Procedures for Calculating PM<sub>2.5</sub> and PM<sub>10</sub> Emissions for the NEI



# NEI Methods for Calculating PM<sub>2.5</sub> Emissions



- How are PM conversion factors developed?
  - Using ratios of AP-42 particle-size-specific emission factors
- What factors are needed?
  - S/L/T agencies provided either primary and/or filterable PM and/or PM<sub>10</sub> emissions
  - To prepare filterable PM for input to PM Calculator, need factors to estimate:
    - PM-FIL from PM-CON
    - PM10-FIL from PM10-CON
  - Using PM Calculator output, need factors to estimate:
    - PM-CON from PM10-FIL

# NEI Methods for Calculating PM<sub>2.5</sub> Emissions



## ■ What Factors are on My CD?

- Your CD contains EFs and conversion factors for selected point source categories for your review, comment, and use
- S/L/T agencies should provide comments on methodology to Roy Huntley (EPA/EFIG) 919-541-1060 by February 15, 2002
- Table 1:
  - AP-42 uncontrolled EFs for stationary external and internal fuel combustion sources (for point source SCCs starting with 1 and 2)
  - EFs are converted to common units (lb/MMBtu) to calculate ratios
    - Default Fuel Ash Content = 8%
    - Default Fuel Sulfur Content = 1%
  - Provides EFs by SCC for all forms of PM available in AP-42

# NEI Methods for Calculating PM<sub>2.5</sub> Emissions



## ■ What Factors are on My CD?

### ■ Table 2:

- | Conversion factors calculated from EFs in Table 1
- | Factors to estimate PM-CON are the same for uncontrolled and controlled sources except for flue-gas desulfurization (FGD) scrubbers
- | Step 1. Calculated conversion factors using ratio of AP-42 EFs available for each 8-digit SCC
- | Step 2. Gap filling:
  - Used average of EFs for SCCs with common 6-digits (or fewer digits if necessary) when EFs were not available at 8-digit SCC level

### ■ Table 3:

- | Conversion factors for FGD scrubbers on coal- & oil-fired boilers
- | FGD scrubbers are only controls identified so far that change pre-control condensable fraction (Ref. AP-42)

# NEI Methods for Calculating PM2.5 Emissions

## Sample Calculation of Conversion Factors (SCC 10200202: Industrial Dry Bottom Boiler Burning Pulverized Bituminous Coal)

$$\text{PM10-PRI}_{\text{AP-42}} = \text{PM10-FIL}_{\text{AP-42}} + \text{PM-CON}_{\text{AP-42}}$$
$$0.7777 \frac{\text{lb}}{\text{MMBtu}} = 0.7077 \frac{\text{lb}}{\text{MMBtu}} + 0.07 \frac{\text{lb}}{\text{MMBtu}}$$

(PM10-PRI<sub>STATE</sub> → PM10-FIL<sub>STATE</sub>) conversion factor:

$$\frac{\text{PM10-FIL}_{\text{AP-42}}}{\text{PM10-PRI}_{\text{AP-42}}} = \frac{0.7077 \frac{\text{lb}}{\text{MMBtu}}}{0.7777 \frac{\text{lb}}{\text{MMBtu}}} = 0.90$$

(PM10-FIL<sub>STATE</sub> → PM-CON<sub>STATE</sub>) conversion factor:

$$\frac{\text{PM-CON}_{\text{AP-42}}}{\text{PM10-FIL}_{\text{AP-42}}} = \frac{0.07 \frac{\text{lb}}{\text{MMBtu}}}{0.7077 \frac{\text{lb}}{\text{MMBtu}}} = 0.0989$$



# NEI Methods for Calculating PM<sub>2.5</sub> Emissions



## ■ What Factors are on My CD?

### ■ Table 4:

- | Conversion factors for uncontrolled solid waste disposal (for point source SCCs starting with 5)
- | These factors are very rough due to lack of particle size data
- | Conversion factors are calculated using average EFs calculated from particle-size-specific AP-42 EFs for external and internal combustion SCCs
- | Average EFs used to calculate conversion factors for solid waste disposal are:
  - PM-FIL      1.0728 lb/MMBtu
  - PM10-FIL    0.3383 lb/MMBtu
  - PM-CON      0.0342 lb/MMBtu

# NEI Methods for Calculating PM<sub>2.5</sub> Emissions



- What additional factors will EPA prepare?
  - Industrial processes (for industrial point sources; SCCs starting with 3)
  - Additional SCCs as needed to estimate filterable and condensable PM<sub>2.5</sub> from S/L/T submitted PM and/or PM<sub>10</sub> emissions

# PM Calculator



- EPA tool for calculating uncontrolled/controlled filterable PM<sub>2.5</sub> and PM<sub>10</sub> emissions using AP-42 particle size distributions
- For point sources only
- Contains 2,359 SCCs with PM<sub>10</sub> emissions in 1996 NEI
- Limitations
  - AP-42 particle size data not available for many sources; generic AP-42 profiles are used for many source categories
  - Does not include profiles for all SCCs for which S/L/T agencies submitted PM or PM<sub>10</sub> emissions last summer
  - Results can produce PM<sub>25</sub>-FIL emissions > PM<sub>10</sub>-FIL emissions; need to QA results

# PM Calculator (Cont.)



## Inputs

- Unique ID code to link records to your inventory
- SCC
- Primary and secondary control code, if applicable
- Uncontrolled PM-FIL or PM10-FIL emissions

## Outputs

- PM25-FIL and PM10-FIL emissions by SCC
- Control device code and control efficiency
- “Flags” SCCs that have specific  $PM_{10}$  and/or  $PM_{2.5}$  EFs in FIRE
  - FIRE EFs are better source of  $PM_{10}/PM_{2.5}$  emissions than PM Calculator

# PM Calculator (Cont.)

## Sample Calculations



### ■ Focus

- Calculate controlled PM<sub>25</sub>-FIL emissions
- Calculate overall control efficiency for two control devices in series


### ■ SCC = 10200202 (Industrial Dry Bottom Boiler Burning Pulverized Bituminous Coal)

### ■ Inputs to Calculator

- Example Unique ID = County + Site + Unit + Process IDs
- Uncontrolled PM-FIL Emissions = 25,000 Tons/Year
- Primary Control Device (PCD) Code = 16 (Fabric Filter/High-Temp.)
- Secondary Control Device (SCD) Code = 10 (ESP/High-Temp.)

# PM Calculator (Cont.)

## Sample Calculations



### ■ What does the PM Calculator Use to Calculate Emissions?

- Uncontrolled Particle Size Distribution (PSD) for SCC 10200202 (AP-42)

- | PM25-FIL = 0.06 (fraction of PM-FIL)

- | PM10-FIL = 0.23 (fraction of PM-FIL)

### ■ Particle-Size-Specific Control Efficiencies

- | Fabric Filter

ESP

- | PCD (Ref: AP-42)


SCD (Ref: Generic)

- pCE25-FIL = 98.33%

sCE25-FIL = 96%

# PM Calculator (Cont.)


## Sample Calculations



- Calculate Uncontrolled PM25-FIL Emissions
  - $25,000 \text{ TPY PM-FIL} * 0.06 = 1,500 \text{ TPY PM25-FIL}$
- Calculate Emissions from Primary Control Device (pconPM25-FIL)
  - $\text{Uncontrolled PM25-FIL} * (1 - (\text{pCE25-FIL}/100))$
  - $1,500 \text{ TPY} * (1 - (98.33/100))$
  - 25.05 TPY
- Calculate Emissions from Secondary Control Device (conPM25-FIL)
  - $\text{pconPM25-FIL} * (1 - (\text{sCE25-FIL}/100))$
  - $25.05 * (1 - (96/100))$
  - 1.002 TPY

## PM Calculator (Cont.)

### Sample Calculations



- Calculate Overall PM25-FIL Control Efficiency for Two Control Devices
  - $(\text{Inlet} - \text{Outlet}) / \text{Inlet} * 100$
  - $(1,500 - 1.002) / 1,500 * 100$
  - 99.93%



# Future Information Needs



## ■ Data Needs

- Need emission factors for filterable and condensable  $PM_{2.5}$  for wide variety of sources
- NEI methods need improvement/high degree of uncertainty but best we have now
- Prefer S/L/T data to default NEI method for filterable and condensable  $PM_{10}$  and  $PM_{2.5}$

## ■ Source Apportionment Studies

- Current speciation profiles for Organic/Inorganic PM outdated
- EPA is working towards developing methods to speciate stack measurements of PM that are consistent with ambient monitoring methods